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THE DIGITAL COMPUTER AS AN
AUTOMATIC TEACHING DEVICE

PETER D. STOGIS

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Peter D. Stogis

Submitted in partial fulfillment of
the requirement for the degree of

MASTER OF SCIENCE

by

PETER D. STOGIS

United States Naval Postgraduate School
Monterey, California

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ABSTRACT

One way in which the computer can be used in a teaching situation is by making available to the instructor a computer language which permits him to prepare course material according to the precepts of programmed instruction. The computer then administers the course to the student in the manner prescribed by the instructor. This method is developed using a typewriter as the computer input-output device. The potential role of computer assisted instruction is also discussed.

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1. Introduction.

It is generally accepted in the educational community that there is now, and there will be in the future, an increasing shortage of qualified instructors and educational facilities at all levels.

To alleviate these problems, attempts are being made to develop more efficient educational processes. Amongst the physical aids to instruction which have already been introduced are slides, movies, books, models, mock-ups and closed-circuit and broadcast educational television. More lately, programmed texts and computer assisted instruction have been added.

Programmed instruction is founded on the results of psychological research into the human learning process. Basically, it is suggested by this research that small segments of information should be presented, followed by questions which the student must successfully answer before proceeding. Many textbooks such as Encyclopedia Britannica's TEMAC series have adopted this technique.

Some experimentation has been conducted using electronic digital computers as the device to exploit the philosophy of programmed instruction [1,4,7,10,11]. The computer's speed permits considerable analysis of the student's responses so that he may be routed through the course of instruction in the manner most suited to his individual capabilities. The computer can be used at the same time to tabulate and analyze the student's responses. This tabulation can assist the instructor in evaluating the effectiveness of his course and the abilities of individual students and groups of students.

In the interest of economy, the computer could be time-shared between several students and/or instructors and could also be used for non-instructional tasks.

The purpose of this paper is to discuss the programming of a computer for use as a teaching device and to analyze its potential.

2. Essential Characteristics of Programmed Instruction.

Programmed instruction as envisioned by psychologists differs from conventional methods in that it programs the learning process through which an individual must pass to acquire specific knowledge [14].

It does this by presenting discrete increments of carefully ordered information to the student and by requiring his comprehension of each increment before continuing. It has the further advantage of providing the student with immediate feedback concerning the correctness of each of his responses. This permits self pacing and tends to produce a lower error rate.

To be of value, programmed instruction must either assist the instructor in his normal task and/or replace some of his efforts by a procedure which is at least as effective as his normal teaching processes. Since face to face contact is not a characteristic of programmed instruction, some tools, such as personal observation, will not be available to the instructor. On the other hand, some teaching techniques can be implemented very effectively.

The important psychological principles behind the learning process are [2] :

a. Participation. The more actively a student participates in a learning experience, the more attentive and motivated he is, the more he retains, and the more effective is the experience.

b. Reward. Students learn best when their efforts are rewarded.

c. Immediacy of reinforcement. The more immediate the acknowledgment, reward and/or correction, the more effective is the learning.

d. Knowledge of results. Students learn best when they know whether their response to a question is right or wrong.

e. Individual difference. The closer the learning situation matches each individual's needs, capacity, and capability, the more effective is the learning.

Before computer programs (software) can be written, these principles must be further catagorized in relation to the mechanics of their application. The software must allow the author to present or provide:

a. Reading assignments or textual material.

b. Questions.

c. Timely requests for student responses.

d. Anticipated correct or incorrect answers to be compared with student responses.

e. Comments for anticipated and unanticipated student responses.

f. Branching through basic and remedial course material in a sequence which can be conditioned by the student's performance.

3. Equipment.

The Control Data Corporation (CDC) model 160 computer was used for this project. It is a small general purpose computer having 4096 12-bit words of core storage and a 6.4 usec cycle time.

A CDC model 163 magnetic tape unit has been used for additional storage. The United States Naval Postgraduate School installation has available a CDC model 161 typewriter and a Data Display Corporation model 65 display unit for use as man/machine interaction devices. The typewriter was selected because of its relative ease of programming and its immediate location to the computer.

4. Application of the Computer to Programmed Instruction.

In section 2, the tasks which the instructor wishes to have performed by the programmed teaching device were listed. Shorthand notations (pseudo operation codes) are now assigned to these tasks so that the computer program can recognize the instructor's intentions (Table 1).

The author's course segments then become the arguments of the pseudo operation codes. Briefly, the author might supply a reading assignment (rd), then a question (qu), followed by anticipated correct answers (ca and cb) and anticipated wrong answers (wa and wb). Interspersed amongst the above may be comments the instructor desires to deliver for anticipated and unanticipated student responses (ty and un). Labeling and branching information are also supplied by the instructor to control the flow of course material to the student. A simple example is shown in Figure 1.

Editing procedures are provided to permit the instructor to revise his course as required.

The instructor is free to write his course in a manner commensurate with his imagination and ingenuity; however, because hardware is an integral part of the system, certain rules of procedure and format are necessary. The computer program has been written so that these rules are few in number and as simple as possible. Detailed operating instructions for the writing of a course will be found in Appendix II.

TABLE 1.

PSEUDO OPERATION CODES FOR USE BY THE INSTRUCTOR

Op code	Argument description
rd	A reading assignment, textual material or general comment.
qu	A question to be presented to the student.
ca	The best correct answer of a set of correct answers.
cb	Secondary correct answers of the same set.
wa	The first wrong answer of a set of wrong answers.
wb	Secondary wrong answers of the same set.
ty	A comment to be presented if the student responded with an argument of a ca, cb, cb..... set or a wa, wb, wb..... set.
un	A comment to be presented if the student response does not match any of the supplied answers.
br	A jump instruction.

first

rd SAMPLE COURSE
Read Section 4.1 of the course text "Modern Algebra."

qu Solve the following equations for x:

$$x + y = 2$$

$$x - y = 4$$

ca 3

cb 3.0

ty Correct

br second

W3 -1

wb -1.0

ty You have solved for y. Try again.

un Check your typing and try again.

br 1st help

1st help

qu To solve for x , it is necessary to reduce the two equations in two unknowns to one equation in x . The simplest way to perform this operation is by adding the two equations. Now, what is the value for x ?

ca 3

cb 3.0

ty Correct

br second

un The correct answer is

$$\begin{array}{r} x + y = 2 \\ + \quad x - y = 4 \\ \hline 2x = 6 \\ x = 3 \end{array}$$

second

Figure 1. The use of pseudo operation codes by the instructor.

A separate mode of operation is provided for the student. In this mode the computer administers the author's course to the student. The sample course of Figure 1 could unfold in a different manner to different students as indicated, for example, in Figures 2 and 3. The student may also ask for help in which case the computer responds with the correct answer (ca).

Student responses are recorded to permit grading and the analysis of course effectiveness.

Operating instructions for the student are described in Appendix III.

The course material may be entered into the system by a typist or by the instructor himself. In the latter case, the instructor can change his role from professor to student in order to check the instructional mode of operation.

first

SAMPLE COURSE

Read Section 4.1 of the course text "Modern Algebra."

(Student signals completion of the reading assignment)

Solve the following equations for x:

$$x + y = 2$$

$$x - y = 4$$

3

Correct

second

Figure 2. The result of student A's enrollment in the sample course of Figure 1.

first

SAMPLE COURSE

Read Section 4.1 of the course text "Modern Algebra."

(Student signals completion of the reading assignment)

Solve the following equations for x:

$$x + y = 2$$

$$x - y = 4$$

4

Check your typing and try again.

4

To solve for x, it is necessary to reduce the two equations in two unknowns to one equation in x. The simplest way to perform this operation is by adding the two equations. Now, what is the value for x?

-1

The correct answer is

$$\begin{array}{rcl} & x + y = 2 & \\ + & x - y = 4 & \\ \hline 2x & & = 6 \\ & x = 3 & \end{array}$$

second.....

Figure 3. The result of student B's enrollment in the sample course of Figure 1.

5. System test.

After the programming was completed, a small test course was entered and several "students" were enrolled. It was then possible to test the system for proper functioning. No attempt was made to evaluate the effectiveness of this system in an actual teaching environment.

6. Conclusions.

The Control Data model 160 computer used in this project proved adequate for this application. However, because of the computer program occupied two-thirds of memory, a slight problem developed in the manipulation of course material (Appendix IV). In addition, a computer used in an actual teaching installation should have indexing and memory test instructions in its machine language repertoire for more efficient operation.

It was clear from the beginning that magnetic tape is not a satisfactory medium for intermediate storage. Its serial method of recording required inefficient software techniques and could lead to delays in operation. Both of these problems could be rectified by the use of random access disk files or drums.

The typewriter is considered only moderately effective as an interaction device. Average reading speeds greatly exceed the output speed of any typewriter and the generation of the symbol notation used in some fields can be difficult or even impossible. For example, the manipulations required to type a definite integral ($\int_a^b f(x) dx$), especially from the standpoint of the student, reduce the effectiveness of the man/machine communication.

A device considered more suitable for this application is a cathode ray tube/keyboard combination such as the Data Display Corporation model 65. Textual material could then be presented essentially instantaneously and modification of the character set or type format will generally be more feasible.

Industry is currently developing new devices such as the Rand Tablet [13] which will allow handwritten communication with the computer. These devices would greatly increase the potential of computer assisted instruction.

The pseudo operation codes, listed in Table 1, were sufficient for the course tested; however, a need is recognized for the expansion of the branching code. Situations are anticipated when the instructor may wish to make his branches depend upon the student's performance, as might be measured by the number of help requests, the number of attempts to answer a question or the time taken to respond. The software could easily be expanded to include these facilities.

To fully exploit new ideas in teaching techniques, it might also be desirable to provide means for the instructor to change the software logic. This, however, would make it necessary for the instructor to acquire a knowledge of computer programming.

There has been a suggestion that statistical decision theory could be used to automatically adapt a course to a student's learning characteristic [8]. This represents a rather revolutionary concept but typifies the ideas that are expected to be germinated by the presence of a computer in an educational environment.

Programmed instruction, especially when computer assisted, appears to require a more precise approach to instruction than is the case in conventional circumstances. In the classroom, a teacher can react to each new situation as it arises, but here he must anticipate the student reaction to course material. Of course, the instructor could just

observe the tabulation of student responses and revise his course as required, but it may take some time to acquire a satisfactory sample size. In the meantime, the earlier students would suffer. The new thought patterns required are not considered to present an overwhelming burden to an experienced instructor, but he must anticipate that the preparation of course material will be very slow. This apparent disadvantage is balanced by the fact that the material, once prepared, can be used repeatedly. Several publications are available to assist the instructor in the preparation of programmed instruction [9, 10, 12, 14].

There is, currently, one other aspect of computer assisted instruction which may cause difficulty. When questions require lengthy answers, there are usually many different, but correct, ways in which the answer can be expressed. The computer program would have no difficulty in checking the answers, but the instructor would be hard pressed to supply all possible correct answers. These remarks also apply to plurals, contractions, punctuation, etc. For this reason computer assisted instruction is likely to be more easily applied in the fields of the exact sciences.

At this point, it might be well to point out that the software has been developed with the prerequisite that communication with the computer should be as effortless as possible or, in other words, that the instructor should be isolated from computer programming. To realize this goal a rather complex system program is necessary and it is estimated that a complete system would require in the order of one man year to develop.

Not yet mentioned is the question of cost. Although several organizations have been experimenting with computer assisted instruction, no industrial firm has yet reached a stage of development that would permit cost analysis. At the moment, it is not even clear if it would be more economical for a computer assisted instruction system to be set up with its own small computer or whether it should share part of the operating time of a large computer system. Other important factors include: the potential for reducing the class contact time of the instructor, student usage, and the time required to write a course. The high cost of computers would seem to indicate a high cost of operation; however, it is suspected that a well designed system when optimized in relation to modern hardware technology and the other factors mentioned above could produce a very reasonable cost per student hour.

There has been some effort to compare the effectiveness of computer assisted instruction with classroom instruction [2,5]. Although this author feels that the sample size in many cases was too small to be decidedly conclusive, these studies indicate a slight advantage to computer assisted instruction. The system discussed in this paper was not used in an actual teaching situation; however, feedback to the student was found to be extremely fast---so much so that, at times, it was disconcerting. This by itself is not conclusive since the quality of the feedback is still determined by the instructor; however, it does indicate that computer time is available to incorporate other desirable features as discussed earlier in this section.

Computer assisted instruction is viewed as a potentially powerful addition to the teaching art.

7. Acknowledgments.

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APPENDIX I
EQUIPMENT OPERATION

1. Computer

The program is loaded at program address 0000. Run the program from program address 0000.

2. Tape unit

The course tape is loaded on the CDC 163, which is set to unit 1 and coded parity.

3. Typewriter

Check power on, disconnect switch to AUTO, and the control switch to COMPUTER. Set the first tab stop 10 spaces in from the left margin.

At the start, the computer will request the administrative information described in Appendix II. When the instructor mode is indicated, the computer drives the typewriter to the first tab and types a colon. A carriage return at this juncture indicates that a label or special author function is to follow. If a carriage return is not hit, the computer expects a legal pseudo operation code to follow.

Two double character codes are accepted. A double period signifies an "end of block." A double comma in the instructor mode orders the computer to erase the present line. A restart occurs where the line began before the erase call. In the student mode, the erase code is a carriage return or a double comma.

APPENDIX II

OPERATING INSTRUCTIONS FOR THE WRITING OF A COURSE

The complete list of pseudo operation codes is shown in Table 2.

Rules of format are as follows:

- a. Labels and the op-codes FINIS, STUD and PROF are always written at the left hand margin.
- b. All other operation codes are written at the first tab as indicated automatically by the computer.
- c. Second and successive lines of an argument may start anywhere and there is no limit set on the length.
- d. The termination of labels and the arguments of the pseudo operation codes is signaled by the end of block (EOB) code. The computer will respond with a carriage return.

Rules of procedure are as follows:

- a. A reading assignment must be followed by another reading assignment or by a question.
- b. A question must be followed by a correct answer (ca), a comment (ty), or a branch (br).
- c. A label or the argument of a branch must be ten characters, or less, in length. If more than ten characters are written, the computer will accept only the first ten.
- d. The operation codes "ca" and "cb" are part of a set as are "wa" and "wb". This allows the instructor to initiate the same comment (ty) or branch for a number of student responses.

e. Comments for unanticipated student responses (un) are listed at the end of a course block -- just before a new label -- but may be followed by a branch.

The instructor is then free to use the operation codes as he pleases; however, there are two features of the student mode which the instructor will have to keep in mind. When a "ca" or "cb" operation code is successfully executed, the program will proceed to the next "rd" or "qu", after typing any "ty" arguments associated with the "ca" - "cb" group. This action may be modified by the use of a branch. When a "wa", "wb" or "un" operation code is successfully executed, the computer will wait for another student response to the present question after typing any "ty" arguments. In other words, the program loops back to the "ca" following the present question. Again a branch will modify this procedure and if a branch is not supplied after the last "un" argument, further unanticipated responses will cause a loop condition until a correct answer is finally given.

A sample course as actually entered into the computer is shown in Figure 4.

The computer will output comments to the operator at certain times. These messages are listed in Table 3. Unfortunately, the computer cannot anticipate the instructor's intentions and some course error messages will appear only in the student mode; therefore, it is recommended that the instructor assume the role of a student to check his course.

TABLE 2

PSEUDO OPERATION CODES

<u>Op code</u>	<u>Argument description</u>
rd	A reading assignment, textual material or general comment.
qu	A question to be presented to the student.
ca	The best correct answer of a set of correct answers. This could be the only member of the set.
cb	Secondary correct answers of the same set.
wa	The first wrong answer of a set of wrong answers. This could be the only member of the set.
wb	Secondary wrong answers of the same set.
ty	A comment to be presented if the student responded with an argument of a ca, cb, cb.... set or a wa, wb, wb..... set.
un	A comment to be presented if the student response does not match any of the supplied answers.
br	A jump instruction.

SPECIAL FUNCTION CODES

<u>Label field</u>	<u>Description</u>
Instructor codes	
FINIS	This code signals the completion of the segment of the course the instructor wishes to write at one sitting.
STUD	This code will switch the instructor into the student mode.
PROF	This code will switch the instructor back into his own mode and is used only after the use of STUD.

Student codes

GO TO XXXX The XXXX is a four digit label identifier obtained from the course index. This statement is used by a student when he desires to go to a different course area.

HELP When typed instead of a normal response, the computer gives the correct answer to the current question.

STOP Indicates the student desires to terminate his instruction.

TABLE 3

DESCRIPTION OF COMPUTER MESSAGES TO AN OPERATOR

Message	Description and action required.
TYPE S FOR STUDENT OR P FOR PROF	This is the first message typed after the initial start and sets the mode of operation.
TYPE O FOR OLD OR N FOR NEW	Used in the instruction mode, this action informs the computer that course is being continued or a new course will be written.
TYPE LAST NAME	A request for the identity of the student.
TYPE DESIRED 4 DIGIT START NUMBER	Allows student to choose his starting point.
ERROR IN OP CODE. TRY AGAIN.	The author has used an illegal op code.
NO CR BEFORE EOB. TRY AGAIN.	A carriage return is not allowed before the EOB code when typing a label or the argument to a branch code.
DUPLICATE LABEL. TRY AGAIN.	Duplicate labels are not accepted.
YOUR LAST COURSE RECORD IS:	When an old course is being continued, the last course block is typed out to the instructor. This heading precedes the type out.
Line erased.	Informs the operator that the computer has accepted the erase call.
THE CORRECT ANSWER IS:	Given when the student has requested help.
COURSE ERROR. INSTRUCTIONS TERMINATED.	Typed out when the computer has found an unresolvable conflict.

TYPE S FOR STUDENT OR P FOR PROF.

P

TYPE O FOR OLD OR N FOR NEW

N

first..

:

:rd

SAMPLE COURSE

Read Section 4.1 of the course text "Modern Algebra."

..

:qu Solve the following equations for x:

$$x + y = 2$$

$$x - y = 4$$

..

:ca 3..

:cb 3.0..

:ty Correct. ..

:br second..

:wa -1..

:wb -1.0..

:ty You have solved for y. Try again. ..

:un Check your typing and try again. ..

:br 1st help..

:

1st help..

:qu To solve for x, it is necessary to reduce the two equations in two unknowns to one equation in x. The simplest way to perform this operation is by adding the two equations. Now, what is the value for x?..

:cx

ERROR IN OP CODE. TRY AGAIN.

:ca 3..

:cb 3.0..

:ty Correct. ..

:br second..

:un The correct answer is:

$$\begin{array}{r} x + y = 2 \\ + \quad x - y = 4 \\ \hline 2x = 6 \end{array}$$

Line erased.

$$\begin{array}{r} 2x = 6 \\ x = 3.. \end{array}$$

:

second..

:qu (more course would be added here) WE will insert some random material. ..

:ca 546..

:ty You are correct. ..

:ty This exercise is continued on the next page. ..

Figure 4. A sample course as entered into the computer. (Page 1 of 2)


```

:un You have given an answer which is not logical.
Try again. ..
:br third..
:
stud.. (Here the author wishes to check his course )
TYPE DESIRED 4 DIGIT START NUMBER

0001..
first 0001

SAMPLE COURSE
Read Section 4.1 of the course text Modern Algebra.

..
Solve the following equations for x:


$$\begin{aligned} x + y &= 2 \\ x - y &= 4 \end{aligned}$$


4..
Check your typing and try again.
-1..
You have solved for y. Try again.
help..

THE CORRECT ANSWER IS
3
3..
Correct.

second 0002
(more course would be added here) WE will insert
some random material.
547..
You have given an answer which is not logical.
Try again.
prof.. (Here the author returns to writing his course)

YOUR LAST COURSE RECORD IS:
second 0002
qu (more course would be added here) WE will insert
some random material.
ca 546
ty You are correct.
ty This exercise is continued on the next page.
un You have given an answer which is not logical.
Try again.
br third 0004

:
finis..
TYPE S FOR STUDENT OR P FOR PROF.

```

Figure 4. A sample course as entered into the computer. (Page 2 of 2)

APPENDIX III

OPERATING INSTRUCTIONS FOR A STUDENT

At the start, the computer will request the student's name. The student enters his name on the typewriter and types an EOB. The computer will then generate the following message: "TYPE 4 DIGIT START NUMBER." This number (greater than 0000) refers to the label identifier listed in the course index. After being informed of the desired starting point, the computer will go there and start the course of instruction.

Anytime the typewriter is positioned at the left hand margin and the INPUT light is on, the computer is waiting for a response from the student. In the case of a reading assignment, textual material or general comment just preceding, the proper response is an EOB code. In all other cases the student should type his answer followed by an EOB code.

Several special codes may be used instead of a normal response. "HELP" will signal the computer to produce the correct answer to the question. After the correct answer has been typed out the computer will wait for the student to type back the answer exactly as it was given. If the student desires to skip or return to a given course area he types "GO TO XXXX". XXXX is the same number described in the first paragraph. The code word "STOP" will terminate instruction. All special codes must be followed by an EOB.

If the student makes a typing error, a carriage return will signal a erase code.

Refer to Table 3, Appendix II for error messages.

APPENDIX IV

SOFTWARE SPECIFICATIONS

All information processing is performed in BCD code. All characters are handled in packed form --- two BCD characters per computer word.

Course information is recorded on magnetic tape in 100 BCD character record lengths. A typewriter line comprises one record. The line is transferred to tape when a carriage return key is hit.

A course block is considered to be that section of course material between labels but including the identifying label. An end-of-file mark is written on the tape just before a new label. Course material is read into the computer memory by course blocks. The present program length restricts course block lengths to a maximum of 42 typewriter lines.

Only 54 of the 64 possible octal codes are utilized for character representation. Six of the remaining codes were used to identify special course and typewriter functions as follows:

Tab	51	Carriage Return	55
Backspace	56	Upper Case	16
Lower Case	76	End of Block	36

The computer ignores spaces in the arguments of the codes "ca", "cb", "wa", and "wb" and in the student's response.

In the instructor mode, the software generates a symbol table to store information regarding labels and the branch arguments. Each entry in the symbol table occupies six computer words and its bit structure is depicted in Figure 5. This symbol table is located at the end of a course tape. It is read in when the instructor mode

is called and is dumped to tape when the instructor mode is terminated by the label "FINIS". Figure 6 depicts the magnetic tape layout.

The flow diagrams are shown in Figures 7, 8 and 9.

The computer listing is contained in Appendix V. Definitions of significant symbolic addresses are given in Appendix VI and a cross reference table for the listing will be found in Appendix VII.

Computer word:		Bit	11	10	9	8	7	6	5	4	3	2	1	0
Word	Bit	Use												
1	11	A "1" indicates the symbol is used as a label.												
	10	A "1" indicates the symbol is used as a branch.												
	9	Not used.												
	8-0	A three digit octal reference number assigned to the symbol.												
2-6		Symbol characters packed two per word.												

Figure 5. Bit structure of a entry in the symbol table.

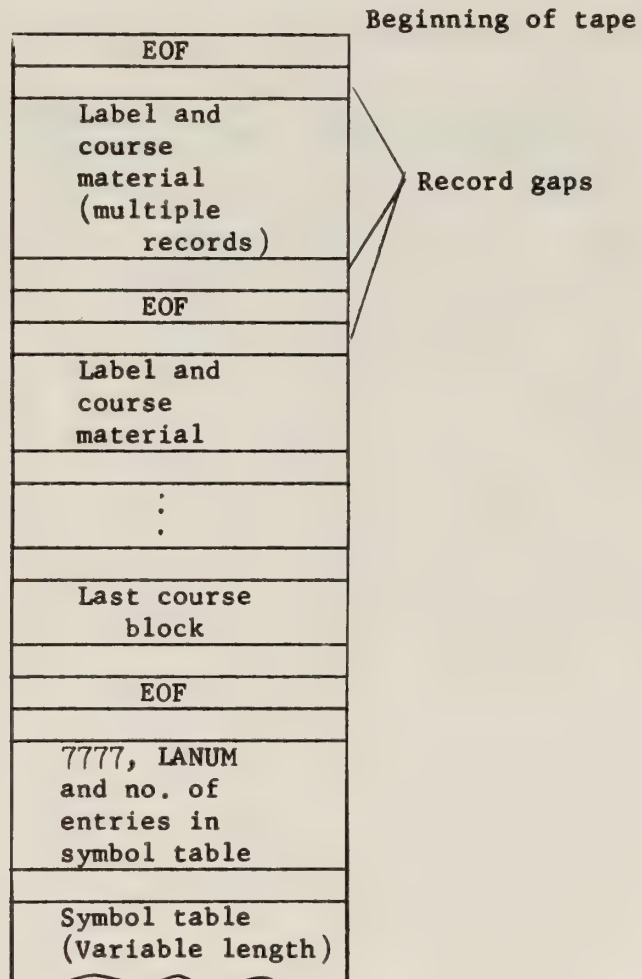


Figure 6. Magnetic tape layout.

MASTER PROG.
ON PAPER TAPE

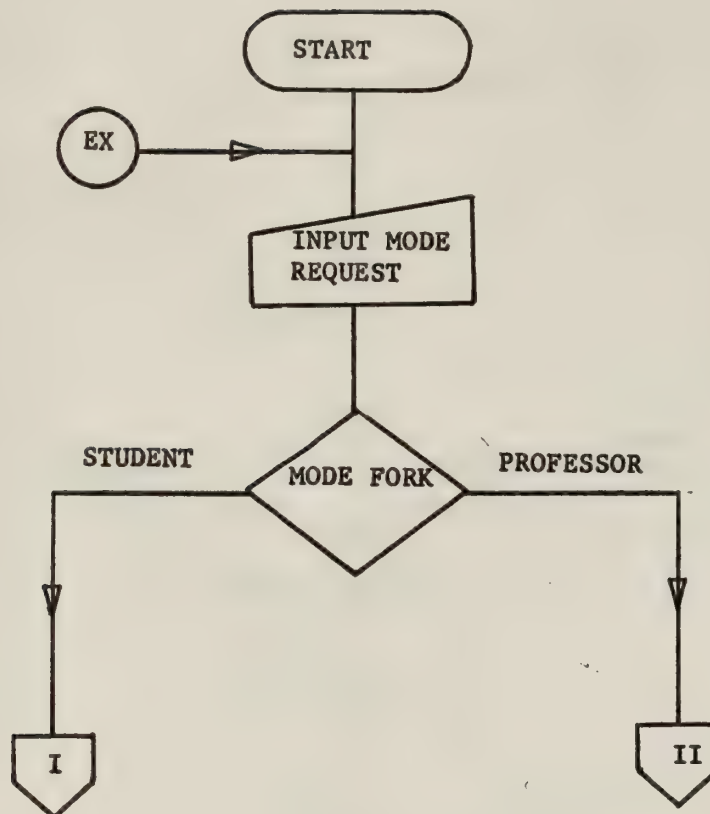


Figure 7. System Flow Diagram - Mode Control.

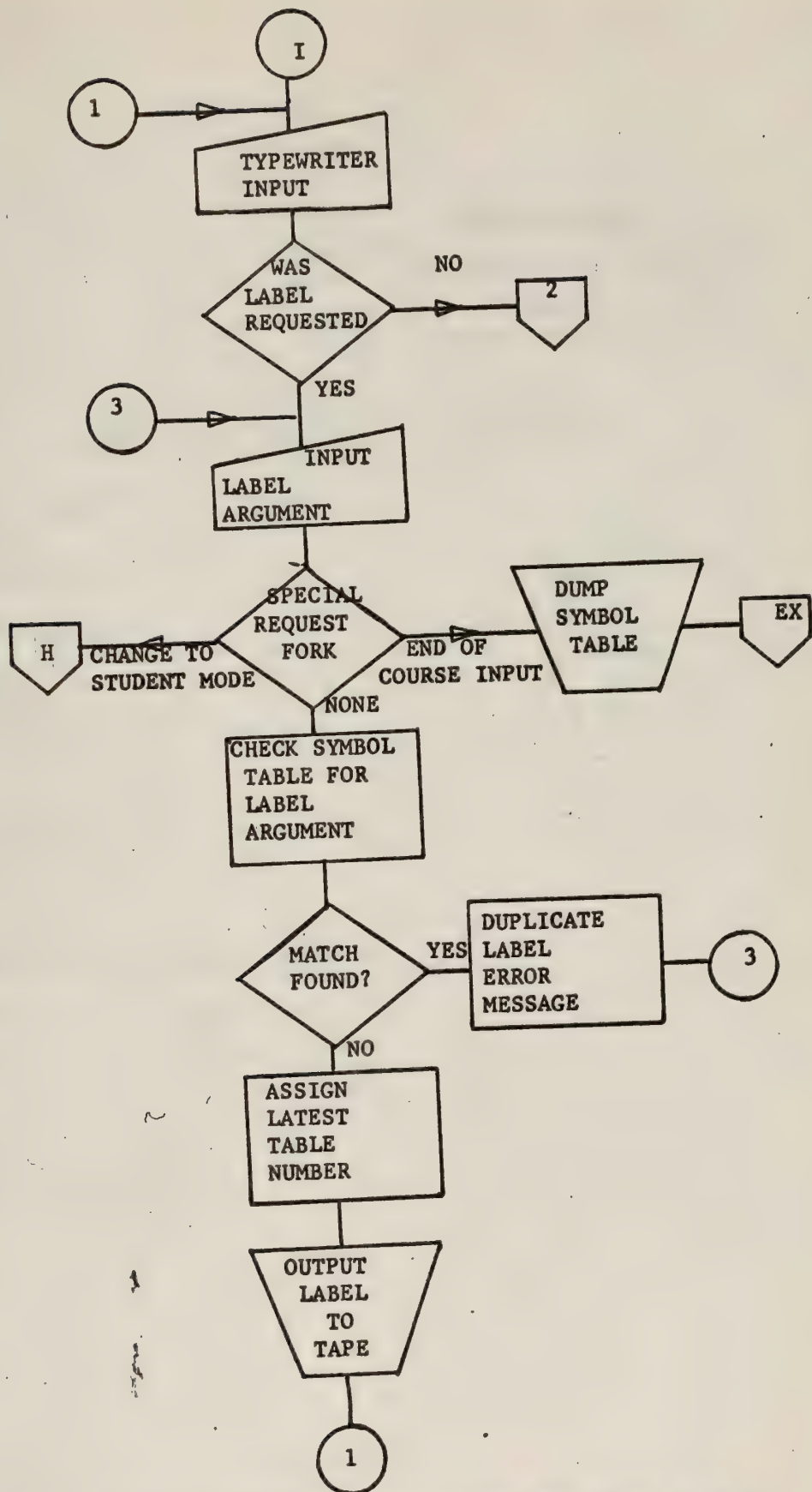


Figure 8. System Flow Diagram - Instructor Mode (Page 1 of 2)

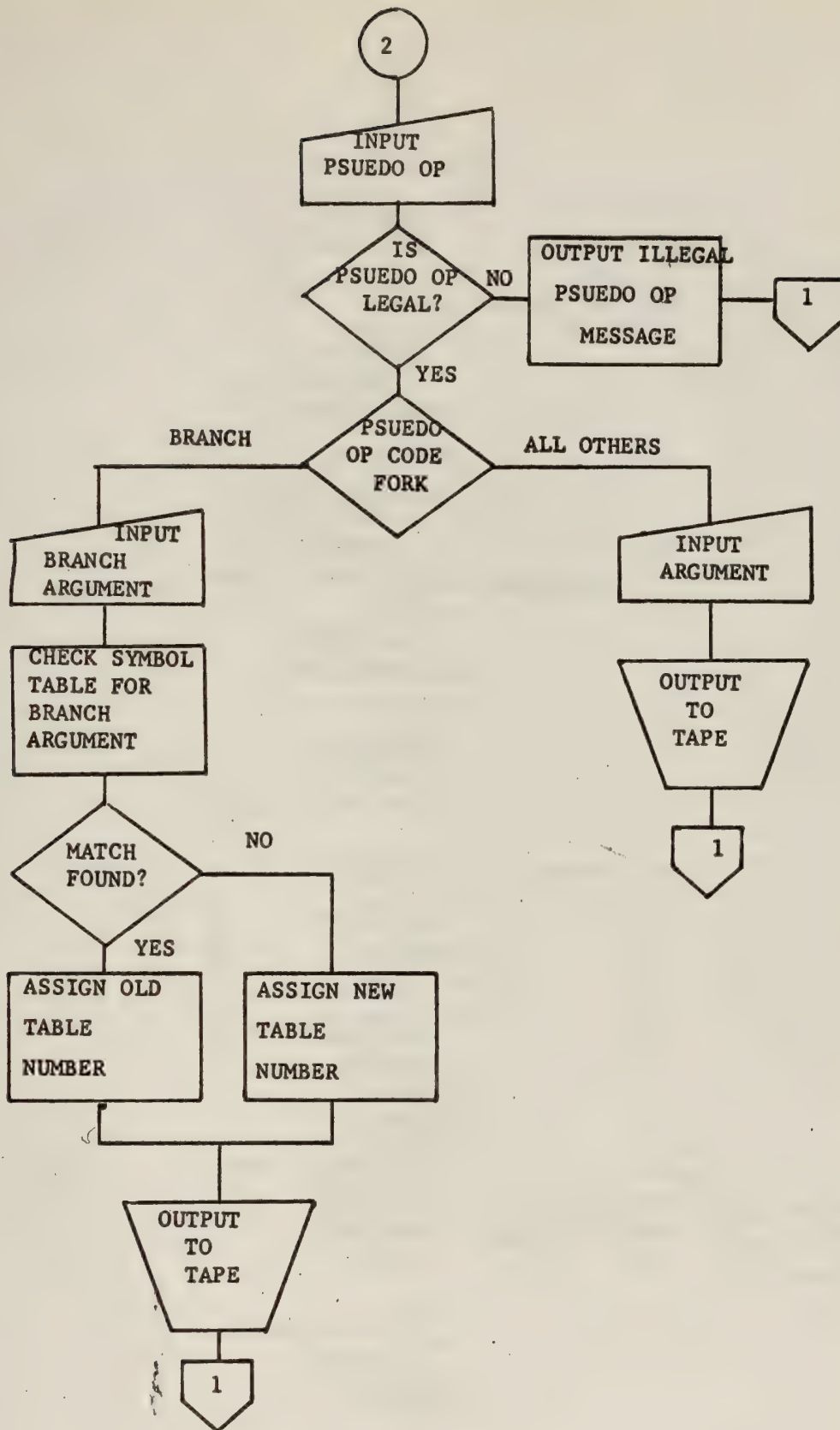


Figure 8. System Flow Diagram - Instructor Mode (Page 2 of 2)

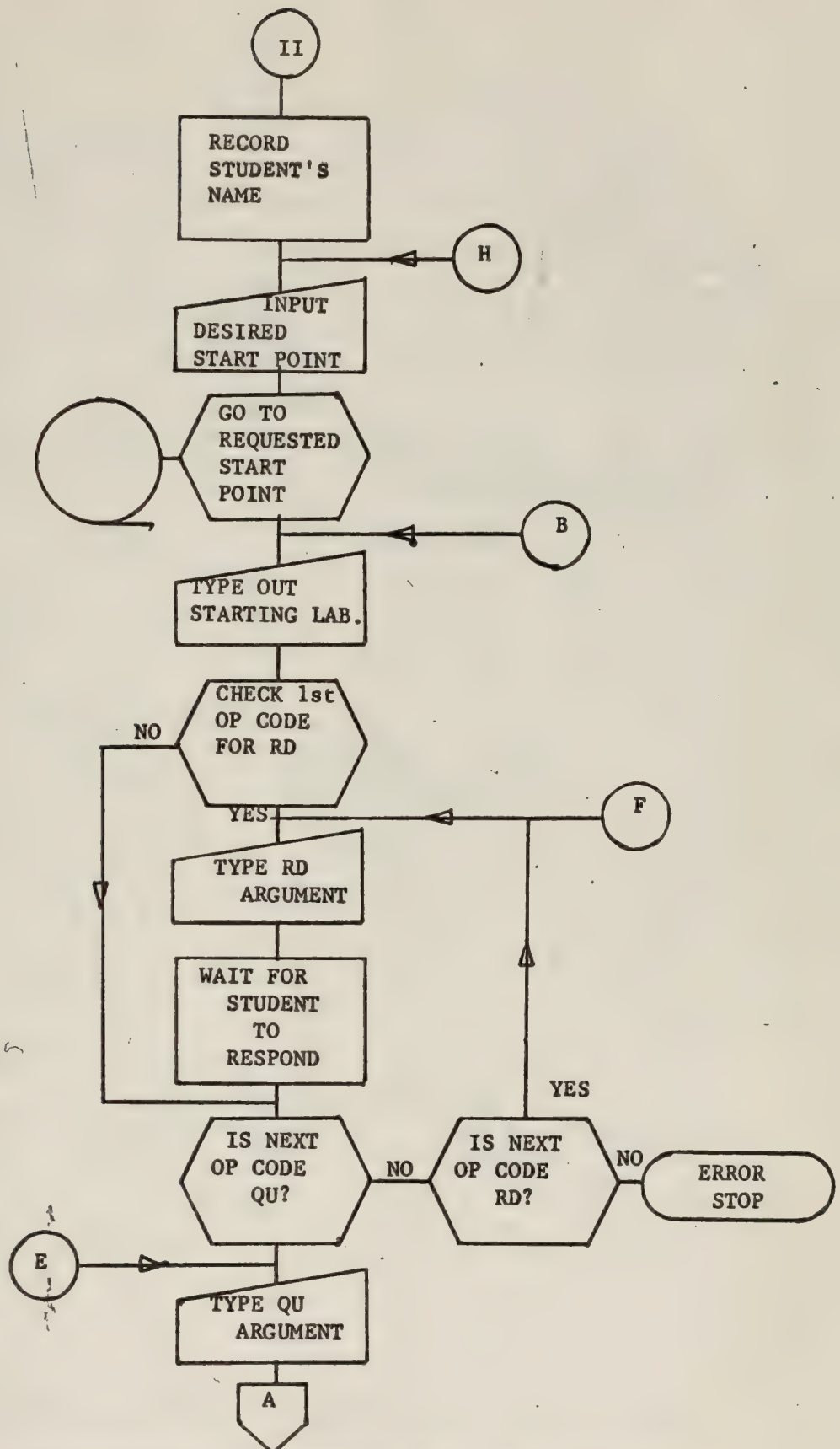


Figure 9. System Flow Diagram - Student Mode (Page 1 of 3)

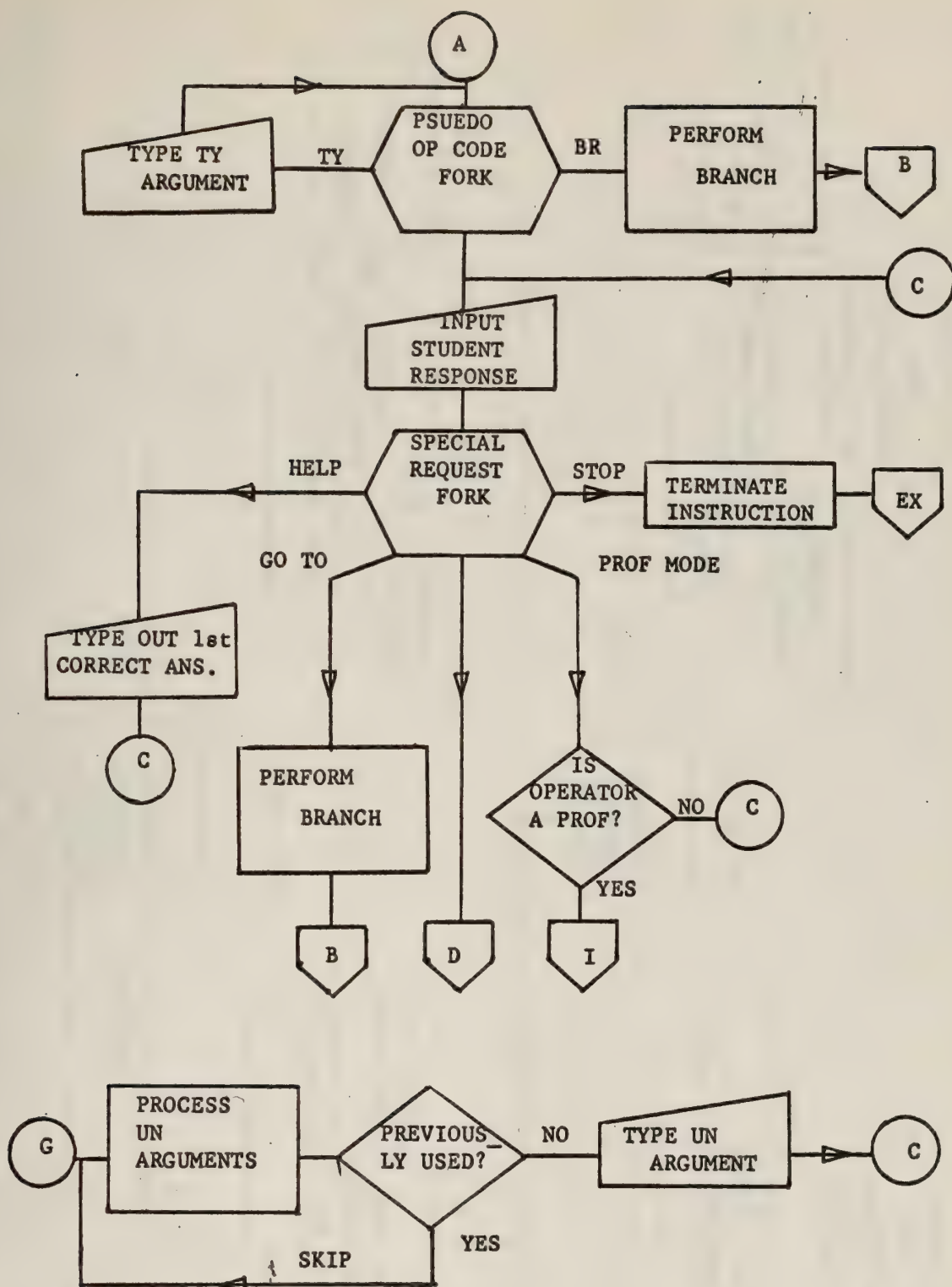


Figure 9. System Flow Diagram - Student Mode (Page 2 of 3)

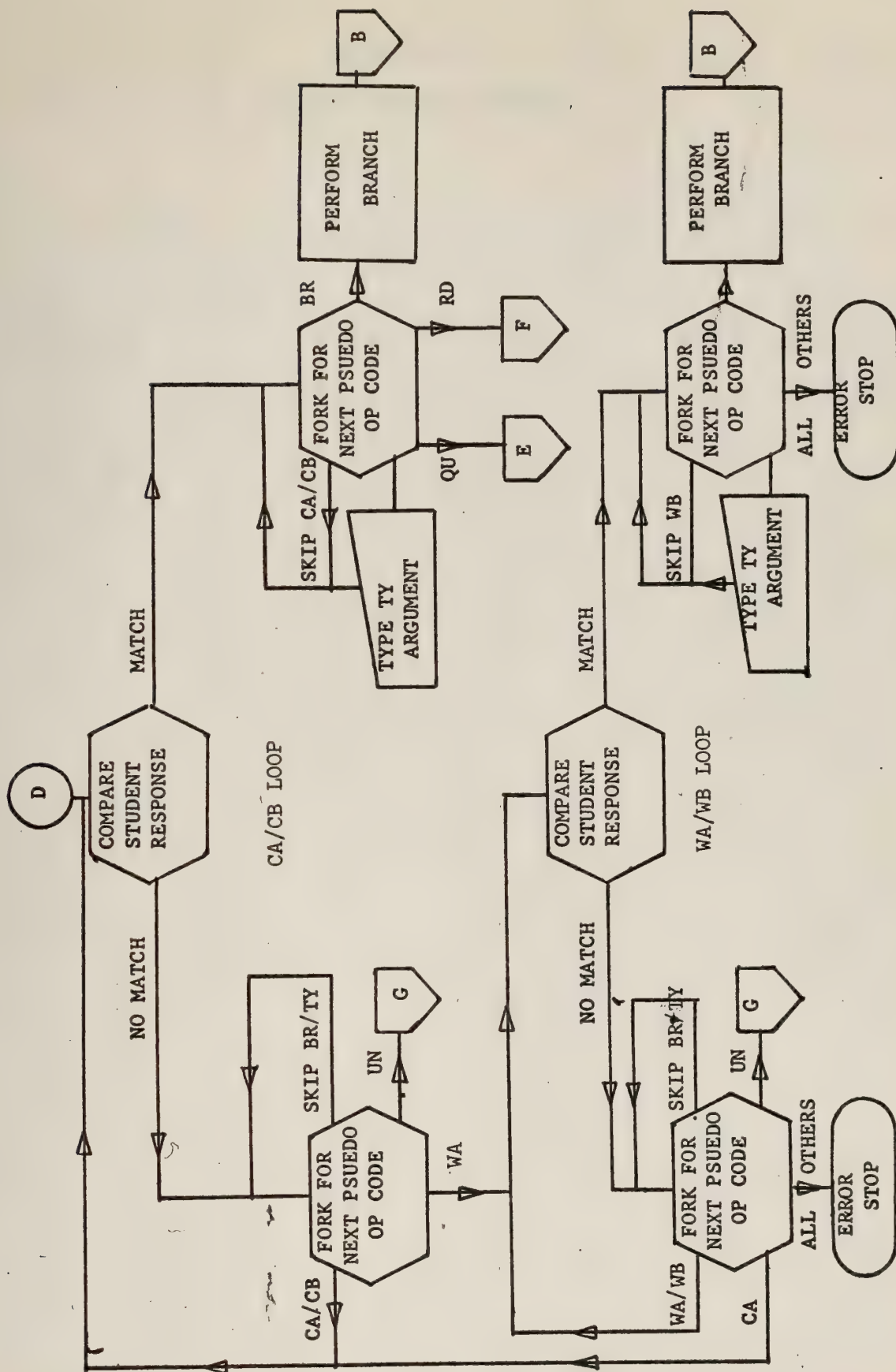


Figure 9. System Flow Diagram - Student Mode (Page 3 of 3)

APPENDIX V
COMPUTER PROGRAM LISTING

REM
REM
REM
REM
CON
JFI

0000	0000	0000	0000
0001	0001	0001	0001
0002	0002	0002	0002
0003	0003	0003	0003
0004	0004	0004	0004
0005	0005	0005	0005
0006	0006	0006	0006
0007	0007	0007	0007
0010	0010	0010	0010
0011	0011	0011	0011
0012	0012	0012	0012
0013	0013	0013	0013
0014	0014	0014	0014
0015	0015	0015	0015
0016	0016	0016	0016
0017	0017	0017	0017
0020	0020	0020	0020
0021	0021	0021	0021
0022	0022	0022	0022
0023	0023	0023	0023
0024	0024	0024	0024
0025	0025	0025	0025
0026	0026	0026	0026
0027	0027	0027	0027
0030	0030	0030	0030
0031	0031	0031	0031
0032	0032	0032	0032
0033	0033	0033	0033
0034	0034	0034	0034
0035	0035	0035	0035
0036	0036	0036	0036
0037	0037	0037	0037
0040	0040	0040	0040
0041	0041	0041	0041
0042	0042	0042	0042
0043	0043	0043	0043
0044	0044	0044	0044
0045	0045	0045	0045
0046	0046	0046	0046

RELAY
RELAY2
ON/OFF
SWITCH
OUTIND
TYPBUF
EOC
LASENT
LANUM
GOTO
EOBFLG
DO
RE
ME
CON1
CASETR
TEMLBF
MATCOL
MATIND
BUFCOL
BUFIN
DPLINE
CNTR1
CNTR2
CNTR3
CNTR4
CNTR5
CNTR6
CNTR7
RETURN
BCDOCT
TAPE
BCDTYPE
TYPINP
PACK

0
1
100
START
START2
5252

STOP +50D

STOP +1
7576

Z9Z001
Z9Z002
Z9Z003
Z9Z004
Z9Z005
Z9Z006

EXIT JUMP ALL SUBROUTINES
BCD-OCTAL CONVERSION
OBTAIN TAPE STATUS
GENERAL TAPE I/O ROUTINE
BCD-TYPE CONVERSION ROUTINE
INPUT TYPE AND CONVERT TO BCD

COMPUTER ASSISTED INSTRUCTION
STUDENT AND INSTRUCTOR SECTIONS
28 APRIL 1965 P.D. STOGIS

0047	0050	0051	0052	0053	0054	0055	0056	0057	0060	0061	0062	0063	0070	0071	0072	0073	0074	0075	0076	0077	0100	0101	0102	0103	0104	0105	0106	0107	0110	0111	0112	0113	0114	0115	0116	0117	0120	0121	0122	0123	0124	0125	0126										
MATCH1	TYPIDEC	DECBBCD	NUMPK	OUTTYP	BLKBUFB	DECOCT	TYCON	TAB/LC	RESCOM	CRSERR	ADVLNE	CON	TEMP0	TEMP1	TEMP2	TEMP3	TEMP4	TEMP5	TEMP6	TEMP7	FIRST	PRG	EXF	INAF	ZJF	EXF	INAF	STD	LPN	NZF	ERR	LDD	LPN	ZJF	ERR	LDD	LPN	NZF	EXF	PTA	JPI	NZF	ZJF	TYST1									
2720	2753	2767	3031	3042	3110	3145	3162	3360	3342	3351	3341	3345	0070	0000	0000	0000	0000	0000	0000	0000	0100	7526	7600	6002	0000	7523	7600	4070	0201	6100	2070	2022	6000	0000	2070	0140	0111	7507	0101	0102	6502	6004	4240										
Z9Z007	Z9Z008	Z9Z009	Z9Z010	Z9Z012	Z9Z013	Z9Z014	Z9Z015	Z9Z016	Z9Z017	Z9Z018	Z9Z019	Z9Z020									TYST1																																
																											CHECKS ST FOR MATCH INPUT TYPE																										
																											PACKS REF NUMBERS FOR LA-BR UNPACKS AND OUT ERROR MSGS SETS BUFFER TO BCD BLANKS																										
																											COMPARE STUDENT RESPONSE																										
																											T E M P O R S T O R E																										
																											TYPEWRITER NOT RDY																										
																											WRONG PARITY SELECTED																										
																											TAPE NOT READY																										
																											TAPE UNIT NOT AT LOAD POINT																										

0127	1141	TAST5		1141		
0130	1161	REWND		1161		
0131	0101	BEGIN	PTA	OUTTYP		
0132	7054		JPI	MC6		
0133	4115			MC7		
0134	4140					
0135	7050		PTA	TYPIN		
0136	0715		JPI	15		
0137	6005		SBN	PROF		
0140	7077		ZJF	7		
0141	6507		SBN	7		
0142	7101		NZB	1		
0143	7121		JFI	STUDNT		
0144	1211					
0145	2020	PROF	LDD	CON1		
0146	4070		STD	TEMPO		
0147	0400		LDN	0		
0150	4170		STI	TEMPO		
0151	5470		AOD	3		
0152	6503		NZB			
0153	0101		PTA	OUTTYP		
0154	7054		JPI	M7		
0155	3776			MC1		
0156	4016					
0157	0101		PTA	TYPIN		
0160	7050		JPI	3		
0161	0703		SBN	OLD		
0162	6010		ZJF	3		
0163	0703		SBN	7		
0164	6507		NZB	0		
0165	4000		LDN	LANUM		
0166	4012		STD	CON1		
0167	2025		LDD	MATIND		
0170	4022		STD	RELAY		
0171	7002	OLD	JPI	SEOF		
0172	7512		EXF			
0173	0101		PTA	TASTAT		
0174	7042		JPI	OLD		
0175	6502		NZB	+1		
0176	0101		PTA	TAPE		
0177	7043		JPI	2131		
0200	2131			TEMPO		
0201	0070			TEMP5		
0202	0075					

TYPE = TYPE S FOR STUDENT OR P FOR PROF.

FLEX P

SET SYMBOL TABLE AREA TO ZERO

TYPE= TYPE 0 FOR OLD OR N FOR NEW

0

N REMAINDER

READ OVER EOF

WAIT FOR TAPE RDY
START LOOKING FOR CODES THAT INDICATE
START OF SYMBOL TABLE

0203	SEOF		STAOK		
0204	STAOK	LDD	1131	READ OVER EOF	
0205		SBC	TEMP0		
0206			7777		
0207		NZB	OLD	SYMBOL TABLE NOT FOUND	
0210		LDD	TEMP1		
0211		STD	TEMP0		
0212		PTA			
0213		JPI	BCDOCT		
0214		LS6		HIGH ORDER 6BITS	
0215		STD	TEMP1		
0216		LDD	TEMP2		
0217		STD	TEMP0		
0221		PTA			
0222		JPI	BCDOCT		
0223		RAD	TEMP1	NUMBER WORDS RQD BY ST	
0224		LDF	ST	FORM	
0225		RAD	TEMP1	LWA +	
0226		STD	TERM		
0227		LDD	MATIND	SET STRT OF ADDI ST ENTRIES	
0230		STD	TEMP3	FORM LANUM	
0231		PTA	TEMP0		
0232		JPI			
0233		STD	BCDOCT		
0234		LDD	TEMP3		
0235		STD	TEMP4		
0236		PTA	TEMP0		
0241	RST	JPI	BCDOCT		
0242		RAD	TEMP3		
0243		STD	LANUM		
0244		PTA		READ SYMBOL TABLE	
0245		JPI	TASTAT		
0246		NZB	RST		
0247		PTA			
0250	ST		TAPE		
0251	TERM		2131		
0252			STOP	+50D	
0253	STAOK1	EXF			
0254		PTA	STAOK1		
0255		JPI	BKSP2	BKSP OVER EOF	
0256		NZB			
0257		EXF	TASTAT		
0260			2	BKSP OVER EOF	
			BKSP2		

0261	PTA	TASTAT	READ OVER EOF
0262	JPI	2	OUTPUT (YOUR LAST COURSE
0263	NZB	SEOF1	ENTRY IS)
0264	EXF		
0265	PTA		
0266	JPI	OUTTYP	
0267		M5	
02670		M6	
0271	PTA	TASTAT	
0272	JPI	2	
0273	NZB		
0274	PTA		
0275	JPI		
0276		TAPE	
0277		2131	
0277		STOP	
0277		STOP	
0277		CONT	
0301		20	
0302	LPN	CONT3	
0303	ZJF	BKSP2	
0304	EXF		
0305	PTA		
0306	JPI	TASTAT	
0307	NZB	2	
0307	ZJF	START	
0311		1121	
0312		1131	
0313		STOP	
0313	LDC		
0315		BUFIND	
0316	STD		
0317	PTA	TYCON	
0317	JPI	1	
0320	JFI	RCRS	
0322			
0323	PTA	OUTTYP	
0323	JPI	MC8	
0324		MC13	
0325			
0326	PTA	BLKBUF	
0327	JPI	0	
0330	LDN	CASE	
0331	STD		
0332	PTA	TYPIN	
0333	JPI	45	
0334	SBN	CRA	
0335	ZJR	1	
0336	JFI		

READ OVER EOF
OUTPUT (YOUR LAST COURSE
ENTRY IS)

INPUT COURSE LINE

+50D

EXECU CONTROL TYPEWRITER
JUMP IF NO EOF READ
BKSP OVER EOF

OUTPUT LAST COURSE RECORD TO TYPE

TYPE = CR,TAB,UC,COLON

NEW CHARACTER ALSO IN TEMPO

0337	CRA	LDC	NCR		
0340			STOP		
0341		STD	BUFIND		
0342		LDD	ON/OFF		
0343		STD	SWITCH		
0344		LDN	76		
0345		STD	TEMP2		
0346		PTA			
0347		JPI	PACK		
0350		LON	20		
0351		STD	TEMP2		
0353		PTA			
0354		JPI	PACK		
0355		LCN	10D		
0356		STC			
0357	LALIM				
0360		PTA			
0361		JPI	TYPINP		
0362		PTA			
0363		JPI			
0364		LDD	PACK		
0365		SBN	TEMP2		
0366		ZJF	36		
0367		SBN	LAIN		
0370		ZJF	17		
0371		ZJF	4		
0372		A0B	LALIM		
0373		NZB	LALIM		
0374		ZJF	LAIN		
0375		PTA			
0376		JPI	OUTTYP		
0377			M4		
0400		JPI	M5		
0401		LDC	RELAY		
0402			STOP		
0403		STD			
0404		LDI	TEMPO		
0405		SBC	TEMPO		
0406			7620		
0407		NZF			
0410		A0D	MATCH		
0411		LDI	TEMPO		
0412		SBC	6671		
0413					
0414		NZF	CHKSTU		

SET LOWER CASE IN OUT BUF

CONVERSION IN A
AND TEMP2

EOB CHK

CR CHK

ERROR MSG FOR CR IN MIDDLE
OF LABEL

BCD LC/SPACE

BCD FI

0415	ADD	TEMPO			
0416	LDI	TEMPO			
0417	SBC	4571	BCD	NI	
0420	NZF	MATCH			
0421	ADD	TEMPO			
0422	LDI	TEMPO			
0423	SBC	2236	BCD	S/EOB	
0424	NZF	MATCH			
0425	PTA				
0426	JFI	SYM			
0430	JFI	1			
0431		BEGIN			
0432	SBC	3331	BCD	ST REMAINDER	
0433					
0434	NZF	MATCH			
0435	ADD	TEMPO			
0436	LDI	TEMPO			
0437	SBC	2464	BCD	UD	
0440	NZF	MATCH			
0441	PTA				
0442	JFI	SYM			
0443	JFI	1			
0444		DIGIT			
0445		STDUMP			
0446	PTA				
0447	JPI	MATCH1			
0450	SBN	1			
0451	NZF	NOMAT			
0452	LDI	MATCOL			
0453	PJF	6			
0454	PTA				
0455	JPI	OUTTYP			
0456		M3			
0457		M4			
0460	JPI	RELAY			
0461	LDC	4000			
0462					
0463					
0464	RAI	MATCOL			
0465	LPC	777			
0466					
0467					
0468					
0469	SID	TEMPO			
0470	PTA				
0471	JPI	OCTDEC			
0472					

JUMP IF NOT FLAGGED AS LABEL
 DUPLICATE ERROR LABEL MSG
 INSERT LA FLAG

0473	LDD	2026	BUFCOL	
0474	ADN	0610	80	
0475	STD	4027	BUFIND	
0476	PTA	0101		
0477	JPI	7053	NUMPK	
0500	EXC	7500	1111	
0501		1111		
0502	PTA	1101		
0503	JPI	7043	TAPE	
0504		2111	2111	
0505		4332	STOP	
0506		4414	START	
0507		0322	LANUM	
0510		5412	777	
0511	NOMAT	3777		
0512		6302		
0513		0000	2	
0514		0012	LANUM	
0515		3200	4000	
0516		4000		
0517		4125	MATIND	
0520		0505	5	
0521		4000		
0522		0200		
0523		2070	BUFCOL	
0524		4075	TEMPO	
0526		2071	MATIND	
0530		4025	TEMP1	
0531		5425	MATIND	
0532		2170	TEMPO	
0533		4125	MATIND	
0534		5425	TEMPO	
0535		5712	MATIND	
0536		6505	12	
0537		2171	5	
0540		6555	TEMP1	
0541		0607	X5	
0542		4077	2	
0543	STDUMP	7500	TEMP7	
0544		1111	1111	
0545		2200		
0546		7777	7777	
0547		4103	NUMBUF	
0550		4173		

SET LOCA OF LA NO. IN OUT BUF

OUT TYPEWRITER LINE

+50D

GREATER THAN 777 OCTAL

TRANSFER NEW LABEL TO ST

WRITE EOF

062307	Z4	RAM			
066311		LDN	21	+1	
066323		RAB	22	+1	
066334		LDN	23	+1	
066345		RAB	24	+1	
066356		LDN	NUMBUF	+6	
066367		RAB			
066370		SBC			
066412		ZJF	4		
066423		LDD	LANUM		
066434		STD	TEMP4		
066445		NZB	Z5		
066467		PTA	TAPE		
066477		JPI	2111		
066512			NUMBUF	+5	
066523		RESUM	RESUM		
066534			TEMP5		
066545		LDD	FWA		
066556		ADF	LWA		
066567		PTA	TAPE		
066577		JPI	2111		
066610			STOP	+50D	
066623		FWA			
066634		LWA			
066645		RESU	RESU		
066656		ADN	1		
066667		NZB	1		
066670		EXC	1161		
066712		PTA	TASTAT		
066723		JPI	2		
066734		NZB	TEMP7		
066745		JPI	STOP		
066756		LDC			
066767			BUFIND		
066777		STD	ON/OFF		
070012		LDD	SWITCH		
070123		STD	75		
070234		LDN	TEMP2		
070345		STD			

RETURN FOR LANUM PASS
DUMP ST CODES

OUTPUT SYMBOL TABLE

DELAY LOOP

START NOT A LABEL ROUTINE

TAB

0705	PTA	PACK	LOWER CASE
0706	JPI	76	
0707	LON	TEMP2	
0710	PTA	PACK	
0711	JPI	PACK	
0712	PTA	6	
0713	ADN	ICEXIT	
0714	STD	TEMLTR	
0715	LDD	1	
0716	JFI	Z9Z005 +4	SKIP TYPIN OF Z9Z005
0717			
0720	PTA	PACK	
0721	JPI	TYPINP	
0722	PTA	PACK	
0723	JPI	1	
0724	PTA	BUFIND	DECREASE BUFIND TO COMPENSATE
0725	JPI	BUFIND	FOR PACK ROUTINE
0726	LCN	2330	CHECK FOR NORMAL DP CODE
0727	RAD		TY CHECK
0730	LDI	NORMOP	
0731	SBC	115	UN CHECK
0732	ZJF	214	WA CHECK
0733	SBC		
0734	ZJF	NORMOP	WB CHECK
0735	SBC	1	NX CHECK
0736	ZJF	1645	
0737	SBC	275	QU CHECK
0740	ZJF	NORMOP	
0741	SBC	140	RD CHECK
0742	ZJF	NORMOP	
0743	SBC	1000	AD CHECK
0744	ZJF	NORMOP	
0745	SBC	65	BR CHECK
0746	ZJF	BRNOP	
0747	SBC		
0750	ZJF		
0751	SBC		
0752	ZJF		
0753	SBC		
0754	ZJF		
0755	SBC		
0756	ZJF		
0757	SBC		
0760	ZJF		
0761	SBC		
0762	ZJF		

0763	SBC	110	CA CHECK
0764	ZJF	NORMOP	
0765	SBN	1	CB CHECK
0766	ZJF	NORMOP	
0767	SBC	263	FN CHECK
0770	ZJF	NORMOP	
0771	PTA		
0772	JPI	OUTTYP	TYPE=NOT LEGAL CODE
0773		M1	
0774		M3	
0775	JPI	RELAY	
0776	AOD	BUFIND	RESET BUFIND
0777	PTA		
1000	JPI	OUTTYP	TYPE= 1 SPACE
1001		MC13	
1002		MC14	
1003		20	
1004		TEMP2	
1005		PACK	
1006		TYPINP	
1010		PACK	
1011		TEMP2	
1012		36	
1013		EOB1	
1014		17	
1015		NXLN	
1016		TAPE	OUT TYPEWRITER LINE
1017		2111	
1018		STOP	
1019		CONT2	
1020		STOP	
1021		+50D	
1022		BUFIND	
1023		BLKBUF	
1024		NXLN	
1025		55	
1026		TEMP2	
1027			
1028			
1029			
1030			
1031			
1032			
1033			
1034			
1035			
1036			
1037			
1040			

117	LDC	STOP	+1		
1120	STD	BUFCOL		RESET	
1121	LDD	TEMPO			
1122	SBN	1			
1123	NZF	NOMAT1			
1124	LSI	MATCOL			
1125	PJF	3			
1126	LDI	MATCOL			
1127	NZF	X1			
1130	LDC	2000			
1131	RAI	MATCOL		FLAG AS BRANCH	
1132	LPC	777			
1133	STD	TEMPO			
1134	PTA	OCTDEC			
1135	JPI	BUFCOL			
1136	LDD	80		LOCA IN PACKED OUT BUF	
1137	ADN	BUFIND			
1140	STD				
1141	PTA	NUMPK		ADD DESIG NO. TO PACKED LINE	
1142	JPI				
1143	PTA	TAPE			
1144	JPI	2111			
1150		STOP	+50D		
1151		START			
1152		LANUM			
1153	NOMAT1	777			
1154	AOD				
1155	SBC				
1156	NJF	2		SET DESIG NUMBER	
1160	ERR			ADD BR FLAG	
1161	LDD	LANUM			
1162	ADC	2000			
1163	STI	MATCOL			
1164	LCN	5			
1165	STC				
1166	LDD	BUFCOL		AND SHIFT NEW	
1167	ADN	2			
1170	STD	TEMPO			
1171	LDD	MATIND			
1172					
1173					
1174					

DESIG TO SYMBOL

TABLE

TEMP1
MATIND
TEMPO
MATIND
TEMPO
MATIND
13
5

TEMP1
X1

NAMBUF
NAMBF
OUTTYP
MC1
MC2
10D

TYPINP
36
5
NAMBF
NAMBF
7
7

TYPE= TYPE DESIRED 4 DIGIT START NUMBER

DIGIT

STD
AOD
LDI
STI
AOD
AOD
NZB
06
06
LDI
NZB

STUDNT

LDC
STD
PTA
JPI
LCN
STC
PTA
JPI
SBN
ZJF
STI
AOD
AOD
NZB
PTA
JPI
LDC
STD
LDN
STD
LDD
STD
LCN
STC
PTA

71
4025
5425
2170
4125
5425
5713
6505
0600
0600
2171
6553

1175
1176
1177
1200
1201
1202
1203
1204
1205
1206
1207
1210

11
12
13
14
15
16
17
20
21
22
23
24
25
26
27
30
31
32
33
34
35
36
37
40
41
42
43
44
45
46
47
50
51

INPUT 4 NUMBERS AND EOB

1253	MARK	JPI	TYPINP	
1254		PTA	PACK	
1255		JPI	5	
1256		A08	5	
1257		NZ8	TEMP2	
1260		LDD	36	
1261		SBN	DIGIT	
1262		NZ8		
1263		PTA	DECOCT	
1264		JPI	STOP	+1
1266			STOP	
1267		LDD	TEMPO	
1270		ZJB	DIGIT	
1271		STD	GOTO	
1272		EXF	SEOF2	
1273		EXF	TAST7	
1274		INA		
1275		LPN	22	
1276		LPN	3	
1277		NZ8	2	
1300		STD	5	
1301		JFI	0	
1302			CNTRI	
1303	START2	LDC	1	
1304			TASRCH	
1305		STF	CRSBUF	
1306		ADN		
1307		STF	FWA3	
1310		PTA	50D	
1311		JPI	LWA3	
1312			TAPE	
1313			2131	
1314	FWA3			
1315	LWA3			
1316	TAST7			
1317	SEOF2			
1320	INAGAN			
1321		LPN	INAGAN	
1322		NZF	1141	
1323		LDB	1131	
1324		STF	20	
1325		LCM	EOF	
1326		NZF	FWA3	
1327			2	
1328			3	

DO NOT ACCEPT 0000

EOF READ AND TAPE RDY
WAIT FOR RDY

CHECK FOR END OF COURSE

1	JFI	ERROR	+4		
2	LDN	50D			
3	RAB	FWA3			
4	LDN	50D			
5	RAB	LWA3			
6	NZB	START2	+5		
7	LDN	LWA3			
8	STD	LASENT			
9	LDC	CRSBUF			
10					
11	STD	TYPBUF			
12	STD	BUFIND			
13	LDI	TYPBUF			
14	SBC	7620			
15					
16	ZJF	3			
17	PTA	CRSERR			
18	JPI				
19	PTA	OUTTYP			
20	JPI	MC8			
21		MC9			
22	PTA	TYPE = CR			
23	JPI				
24	PTA	CONVERT BCD TO TYPE, EXIT AT CR			
25	JPI	AND SET UP OUTTYP			
26					
27	LDD	TYCON			
28	STD	DECOCT	+10D		
29	PTA	CRSBUF	+11D		
30	JPI	CRSBUF			
31	AOD	TEMPO			
32	LDI	LANUM			
33	SBC				
34		ADVLNE			
35	NZF	BUFIND			
36	PTA	5164			
37	JPI	QU			
38	AOD	TAB/LC			
39	PTA	BUFIND			
40	JPI				
41	PTA	TYCON			
42	JPI				
43	PTA	ADVLNE			
44	JPI	EOBFLG			
45	LDD				

SAVE ENDING ADDR +50 OF COURSE BLOCK
 READ IN BEFORE EOF
 START INDEX ON EACH COURSE LINE
 CHECK 1ST REC FOR LABEL
 TYPE = CR
 CONVERT BCD TO TYPE, EXIT AT CR
 AND SET UP OUTTYP
 STORE LABEL NO. PRESENT BLK
 SKIP TAB/LC
 RD
 SKIP RD OP CODE

EOF
 MORE

1406	6405	ZJB	MORE	+1	LOOP FOR ALL LINES OF RD
1407	0101	PTA	TYPINP		
1410	0704	JPI	36		CHKING FOR EOB RESPONSE TO RD
1411	0736	SBN	3		
1412	6503	NZB			
1413	0101	PTA			
1414	0705	JPI	OUTTYP		TYPE = CR
1415	4154		MC8		
1416	4152		MC9		
1417	5427	AOD	BUFIND		SKIP TAB/LC
1420	2360	LDI	BUFIND		QU
1422	5024	SBC	5024		
1423	5024		QU	-2	RD REMAINDER
1424	6006	ZJF	140		
1425	3600	SBC			ANOTHER RD
1426	0140		MORE	-2	
1427	6430	ZJB	CRSERR		
1430	0101	PTA			
1431	7062	JPI	TAB/LC		SKIP OP CODE
1433	0706	JPI	BUFIND		
1435	5427	AOD			
1436	0705	PTA	TYCON		
1437	0101	JPI	ADVLNE		
1438	7063	JPI	BUFIND		
1440	2027	LDD	ME		
1441	2014	LDD	EOBFLG	+1	SKIP TAB/LC
1442	2407	ZJB	QU		TY
1443	5427	AOD	BUFIND		
1444	2330	LDI	2330		
1445	2330	SBC			ROUTINE SAME AS FOR QU
1446	6417	ZJB	QU	-2	AD REMAINDER
1450	3634	SBC	3634		
1451	3634		2		
1452	3634	NZF			
1453	6770	HLT	65		BR REMAINDER
1454	0765	SBN	3		
1455	6710	NZF	1		
1456	6710	JFI	BR		
1460	2200	SBC	110		CA REMAINDER
1461	3600				
1462	0110	ZJF	INRES		
1463	6003				

QU

1464	PTA	CRSERR	CA NOT FIRST MAJOR FOLLOWING QU
1465	JPI	OUTTYP	TYPE = LC
1466	PTA	MC12	
1467	JPI	MC13	
1470		RESBUF	START OF INPU RESPONSE
1471	LDC		
1472	STD	BUFIND	
1473	LDD	ON/OFF	
1474	STD	SWITCH	
1475	LDN	O	
1476	STD	CASE	
1477	PTA	TYPINP	
1501	JPI	20	SPACE
1502	SBN	3	SKIP SPACES
1503	ZJB	16	EOB REMAINDER
1504	SBN	6	
1505	ZJF	17	CR REMAINDER
1506	SBN	INRES	
1510	PTA	PACK	
1511	JPI	12	
1512	NZB	PACK	PACK IN EOB
1513	PTA		TYPE = CR
1514	JPI	OUTTYP	
1515	PTA	MC8	
1516	JPI	MC9	
1517		RESBUF	
1520	LDC		
1521	STD	TEMPO	
1522	LDI	TEMPO	
1523	SBC	2223	BCD ST
1524			
1525	NZF	A1	
1526	AOD	TEMPO	
1527	LDI	TEMPO	
1528	SBC	4647	BCD OP
1530			
1531	NZF	A2	
1532	PTA		
1533	JPI	OUTTYP	TYPE= INSTRUCTION TERMINATED
1534		MC5.1	
1535		MC6	
1536			
1537			
1540			
1541			

1543	A1	JFI	1	GO REMAINDER
1544		SBC	FIRST	
1545			4523	
1546		NZF	A2	
1547		AOD	TEMPO	
1548		LDI	TEMPO	
1549		SBC	2346	BCD TO
1550		NZF	ACONT	
1551		PTA	DECOCT	
1552		JPI	RESBUF	
1553			RESBUF	
1554		LDN	0	
1555		STD	CNTR1	
1556		JFI	1	
1557		SBC	BRX	
1558			117	HE REMAINDER
1559	A2	NZF	A3	
1560		AOD	TEMPO	
1561		LDI	TEMPO	
1562		SBC	4347	BCD LP
1563		NZF	ACONT	
1564		LDC	CRSBUF	
1565		STD	TEMP7	
1566		AOD	TEMP7	
1567		LDI	TEMP7	
1568		SBC	6361	SKIP TAB/LC
1569		ZJF	4	CA
1570		LDN	50D	
1571		RAD	TEMP7	
1572		NZB	6	
1573		PTA	OUTTYP	
1574		JPI	MC4	TYPE=THE CORRECT ANSWER IS
1575			MC5	
1576		LDD	TEMP7	
1577		AOD	TEMP7	
1578		STD	BUFIND	
1579		PTA	TYCON	
1580		JPI		SKIP OP CODE

1621	0	JFI	1	INRES	PR REMAINDER
1622	1	SBC	5663		
1623	2				
1624	3	NZF	ACONT		
1625	4	AOD	TEMPO		
1626	5	LDI	TEMPO		
1627	6	SBC	4666	BCD OF	
1628	7				
1629	0				
1630	1	NZF	ACONT		
1631	2	EXF	REWND1	SEND TAPE TO LOAD POINT	
1632	3	PTA			
1633	4	JPI	TASTAT		
1634	5	NZB			
1635	6	JFI	2	GO TO PROF ROUTINE	
1636	7		RELY		
1637	0		1161		
1638	1		OLD		
1639	2	LDD	TYPBUF		
1640	3	STD	TEMP3		
1641	4	AOD	TEMP3	SKIP TAB/LC	
1642	5	LDC	RESBUF		
1643	6				
1644	7	STD	TEMP4		
1645	0	AOD	TEMP3	SKIP OP CODE	
1646	1	PTA			
1647	2	JPI	RESCOM		
1648	3	ZJF	WRONG		
1649	4	PTA			
1650	5	JPI	ADVLNE		
1651	6	ZJF	BUFIND	LINE DOES NOT CONTAIN OP CODE	
1652	7		OPLINE	SKIP TAB/LC	
1653	0	JPI	4	CA	
1654	1	LDI	BUFIND		
1655	2	SBD	BUFIND		
1656	3	NZB	6361		
1657	4	AOD			
1658	5	LDI	RIGHT		
1659	6	SBC	1	CB REMAINDER	
1660	7				
1661	0	ZJB	RIGHT		
1662	1	SBN	3745	TY REMAINDER	
1663	2	ZJB			
1664	3	SBC	ADCHK		
1665	4				
1666	5	NZF	TAB/LC	SKIP OP CODE	
1667	6	PTA	BUFIND		
1668	7	JPI			
1669	0	AOD			
1670	1	PTA			
1671	2				
1672	3				
1673	4				
1674	5				

1677	JPI	ADCHK	TYCON		
1700	PTA		ADVLNE		
1701	LDD		EOBFLG		
1702	ZJB		GOAGN	+13D	
1703	NZB		GOAGN		
1704	SBC		3634		AD REMAINDER
1705			2		
1706	NZF		65		
1707	HLT		13		BR REMAINDER
1710	SBN		1		
1711	NZF		BR		
1712	JFI				
1713					
1714	PTA		ADVLNE		
1715	JPI		BUFIND		
1716	LDD		OPLNE		
1717	SBD		4		
1720	NZB		5164		LINE DOES NOT CONTAIN OP CODE
1721	SBC				RD
1722			7		
1723	NZF		4		
1724	ZJF		6777		RD REMAINDER
1725	SBC				
1726			3		
1730	NZF		1		
1731	JFI		MORE	-2	
1732	SBC		7637		QU REMAINDER
1733					
1734	NZB		20		
1735	JFI		1		
1736			QU	-2	
1737					
1740	PTA	WRONG	ADVLNE		
1741	JPI		BUFIND		
1742	LDD		OPLNE		
1743	SBD		4		
1744	NZB				
1745	ADD		BUFIND		SKIP TAB/LC
1746	LDD		BUFIND		CB
1747	SBC		6362		
1750	NZF		5		
1751	LDD		BUFIND		SET UP RESCOM
1752	STD		TEMP3		
1753	JFI		1		

17554	1644	SBC	ACONT	+3	WA	REMAINDER
17555	3600		4276			
17557	4033	ZJF	WA		UN	REMAINDER
17570	3600	SBC	7563			
17601	7563	NZF	NX			
17633	7101	JFI	1			
17634	2135	SBC	UN		NX	REMAINDER
17645	3600		2062			
17667	2062	NZF	2			
17700	7700	HLT				
17711	3600	SBC	1522		BR	REMAINDER
17723	1522	ZJB	WRONG			
17734	1523	ADN	65		AD	REMAINDER
17745	0665	ZJB	WRONG		TY	REMAINDER
17756	6436	SBC	4143			
17777	3600				CA	REMAINDER
20001	4143	ZJB	WRONG			
20004	6441	SBC	4031			
20023	3600					
20034	4031	NZF	5			
20045	6105	LDD	BUFIND			
20067	2027	STD	TEMP3			
20070	4073	JFI	1			
20100	7101	PTA	ACONT	+3		
20111	1644	JPI				
20123	0101	LDD	CRSERR			
20134	7062	STD	BUFIND			
20145	2027	LDC	TEMP3			
20156	4073	STD	RESBUF			
20167	2200	ADD	TEMP4			
20179	4073	PTA	TEMP3			
20201	0101	JPI	RESCOM			
20223	7061	NZF	RIGHT1			
20234	6101	JFI	1			
20245	7101	PTA	WRONG1			
20256	0101	JPI				
20267	7063	LDI	ADVLNE			
20301	2127	SBD	BUFIND			
20319	3430	NZB	OPLINE			
	6504		4			

START NEW CA/CB BLOCK

20334567	GOAGN1	AOD	BUFIND	SKIP TAB/LC
220334567		LDI	2330	TY
220334567		SBC		
220334567		NZF	ADCHK1	
220334567		PTA		
220334567		JPI	TAB/LC	SKIP OP CODE
220334567		AOD	BUFIND	
220334567		PTA		
220334567		JPI	TYCON	
220334567		PTA		
220334567		JPI	ADVLNE	
220334567		LDD	EOBFLG	
220334567		ZJB	GOAGN1	
220334567		NZB	GOAGN1	
220334567	ADCHK1	SBC	3634	AD REMAINDER
220334567		NZF	2	
220334567		HLT		
220334567		SBN	65	BR REMAINDER
220334567		NZF	3	
220334567		JFI	1	
220334567		SBC	BR	WA REMAINDER
220334567			4407	
220334567		ZJF	3	
220334567		SBN	1	WB REMAINDER
220334567		ZJB	RIGHT1	
220334567		LDD	ME	
220334567		STD	TYPBUF	
220334567		JFI	JUMP	
220334567	WRONG1	PTA		
220334567		JPI	ADVLNE	SKIP TAB/LC
220334567		LDI	BUFIND	WB
220334567		SBD	OPLINE	
220334567		NZB	4	
220334567		AOD	BUFIND	
220334567		LDI	BUFIND	
220334567		SBC	2662	
220334567		ZJB	WA	WA REMAINDER
220334567		ADN	1	
220334567		ZJB	WA	UN REMAINDER
220334567		SBC	7563	
220334567		ZJF	UN	

002	SBC	2062	NX REMAINDER
602	NZF	2	
610	HLT		
620	SBC	1522	BR REMAINDER
630			
642	ZJB	WRONG1	
655	ADN	65	AD REMAINDER
667	ZJB	WRONG1	
670	SBC	4143	TY REMAINDER
680			
694	ZJB	WRONG1	
703	SBC	4031	CA REMAINDER
710			
723	NZF	5	
735	LDD	BUFIND	
747	STD	TEMP3	
751	JFI	1	
764		ACONT +3	START NEW CA/CB BLOCK
770	PTA		
781	JPI	CRSERR	
794	AOD	BUFIND	
802	LDI	BUFIND	SKIP OP CODE
815	LPC	7700	
827			
841	ZJF	USED	
852	LDI	BUFIND	MAKE SPACE FOLLOWING UN OP CODE ZERO
867	LPN	77	WHEN UN IS USED
877	STI	BUFIND	
891	PTA		
901	JPI	TAB/LC	
910	PTA	TYCON	
927	JPI		
937	PTA		
951	JPI	ADVLNE	
963	LDD	EOBFLG	
974	ZJB	UN	+12
985	LDD	ME	
1007	STD	TYPBUF	
1017	JFI	1	
1066		INRES	
1101	PTA		
1137	JPI	ADVLNE	
1163	LDI	BUFIND	
1227	SBD	OPLINE	
1330	NZB	USED	
1450			

UN

JUMP
USED

50	ROVREF			OK 1	
21	BOEOF	LDB		1131	
11	OK1	STF		1121	
24		LCM		FWA1	
20				2	
00					
00					
04		NZF		4	
10		LDD		CNTR1	
31		ZJF		BACKW	
26		NZF		ERROR	
07		PTA			
43		JPI		DECOCT	+10D
45				CRSBUF	+11D
13		LDD		GOTO	
70		SBDF		TEMPO	
06		ZJF		FOUND	
30		EXF		ROVEF	
07		PTA			
10		JPI		TASTAT	
22		NZB		2	
33		ZJB		TASRCH	
25	FOUND	EXF		BOVEOF	
00		INA		RELAY2	
31	BACKW	JPI		CNTR1	
20		AOD		REWIND	
75		EXF			
20		PTA		TASTAT	
01		JPI		2	
42		NZB		FOUND	-5
02		ZJB			
15	ERROR	PTA		OUTTYP	
41		JPI		MC7	
07				MC8	
40					
11		PTA		OUTTYP	
51		JPI		MC5.1	
07				MC6	
44		JFI		1	
05				BEGIN	
15				1131	
01				1161	
03	ROVEF			1121	
11	REWIND				
61	BOVEOF				
21					

ADDRESS	INSTR.	OPERAND	REMARKS
0000	LD	20	
0001	LD	26	
0002	LD	24	
0003	LD	20	
0004	LD	2	
0005	LD	2	
0006	LD	2	
0007	LD	2	
0008	LD	2	
0009	LD	2	
0010	LD	2	
0011	LD	2	
0012	LD	2	
0013	LD	2	
0014	LD	2	
0015	LD	2	
0016	LD	2	
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0028	LD	2	
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0030	LD	2	
0031	LD	2	
0032	LD	2	
0033	LD	2	
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0035	LD	2	
0036	LD	2	
0037	LD	2	
0038	LD	2	
0039	LD	2	
0040	LD	2	
0041	LD	2	
0042	LD	2	
0043	LD	2	
0044	LD	2	
0045	LD	2	
0046	LD	2	
0047	LD	2	
0048	LD	2	
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0050	LD	2	
0051	LD	2	
0052	LD	2	
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0054	LD	2	
0055	LD	2	
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0059	LD	2	
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0061	LD	2	
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0064	LD	2	
0065	LD	2	
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0067	LD	2	
0068	LD	2	
0069	LD	2	
0070	LD	2	
0071	LD	2	
0072	LD	2	
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0075	LD	2	
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0080	LD	2	
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0090	LD	2	
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0097	LD	2	
0098	LD	2	
0099	LD	2	
0100	LD	2	
0101	LD	2	
0102	LD	2	
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0108	LD	2	
0109	LD	2	
0110	LD	2	
0111	LD	2	

2441 2442 2443	1141 1121 4444	TAST: BKSP: PARSW	1141 1121 4444	BCDTYP
2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513	0602 4040 2070 6105 4041 4021 0447 6155 6120 0720 6105 4041 4014 0404 6147 0740 6105 0400 4021 0457 6141 2021 6120 2230 3500 4202 2100 0000 3470 6104 2303 0277 6125 5706 3600 3600 6512 0000 2200 3600	REM ADN STD LDD SBN NZF LDN STD LDN NZF SBN NZF LDN STD LDN NZF SBN NZF LDN STD LDN NZF SBN NZF LDN STD LDN NZF LDD NZF LDC STF LDM SBD NZF LDB LPN NZF AOB SBC NZB ERR LDC	2 RETURN 1 TEMPO 16 EOB 1 CASE 47 RETCH 20 LC2 1 EOBFLG 4 RETCH 40 CHARAC 0 CASE 57 RETCH CASE UPC2 CNLC 2 TEMPO 4 3 77 RETCH 6 CNUC 12 CNUC	OUTPUT SPACE FOR EOB

25667	PTA	TYPIN	JUMP IF NOT 2ND PERIOD
25670	JPI	42 CNF	BCD FOR EOB
25571	SBN	36 MP2	
25572	NZF	TCEXIT	
25573	LDN	73	
25574	STD	TEMP2	
25575	JPI	PACK	
25576	LDN	TEMLTR	
25577	STD	CNA	
26000	JPI	TEMLTR	
26001	LDD	40	
26002	NZB	CNG	COMMA CHECK
26003	LDD		
26004	SBN		
26005	NZF		
26006	PTA		
26007	JPI	TYPIN	JUMP IF NO SECOND COMMA
26010	SBN	40	OUT LINE ERASED MESSAGE
26011	NZF	CNH	
26012	PTA		
26013	JPI	GUTTYP	
26014		M6	
26015	LDD	M7	
26016	SBC	TCEXIT	
26017		MARK	
26021	NZF	3	
26022	JFI	1	ERASE IN DIGIT CALL
26023	SBC	MARK2	
26024		-2	
26025		-MARK	
26026	NZF	3	
26027	JFI	1	ERASE IN STUDENT RESPONSE
26030	LDM	INRES	WHERE WAS ERASE CALL
26031	SBC	STOP	
26032		7620	LC/BLANK
26033	NZF	5	
26034	PTA	BLKBUF	
26035	JPI	1	ERASE CALL WAS IN LABEL
26036	JFI	CRA	TAB/LC REMAINDER
26037	SBC	7755	
26040			
26041			
26042			
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26100			

0073	C2CT	EQU	TEMP3
0075	C4CT	EQU	TEMP5
0074	C3CT	EQU	TEMP4
0602	Z9Z010	REM	2 RETURN
4040		REM	TEMP6
2076		ADN	4
6042		STD	12
4072		LDD	TEMP2
6102		NZF	EXI
4072		STD	TEMP2
7040	EXI	JPI	RETURN
0602	Z9Z012	REM	2 NPEXIT
4017		REM	2525
2205		ADN	SWITCH
4005		STD	76
0476		LDN	TEMP2
4072		STD	PACK
0101		PTA	TEMP1
4046		JPI	TEMP6
2071		LDD	DECBCD
4076		STD	PACK
0776		PTA	TEMP3
1012		JPI	TEMP6
1046		PTA	DECBCD
4076		LDD	PACK
0102		STD	TEMP4
7046		PTA	TEMP6
1016		JPI	DECBCD
4076		STD	PACK
0101		PTA	TEMP4
7046		JPI	TEMP6
2076		LDD	DECBCD
4076		STD	PACK
0101		PTA	PACK
7046		JPI	

DEC BCD CONVERSION INPUT IN T6
OUTPUT IN T2

NUMBER PACK

SET PACK SWITCH

PACKS LOWER CASE CODE

30756	LDD	TEMP5
30077	PTA	TEMP6
31001	JPI	DECBCD
31012	JPI	PACK
31023	LDN	55
31034	STD	TEMP2
31045	PTA	PACK
31056	JPI	NPEXIT
31067	JPI	ME
31078	EQU	

NPEXIT

OUTTYP

0602	2	RETURN
04040	RETURN	TEMP0
42070	TEMP0	RETURN
54400	RETURN	TEMP1
24071	TEMP1	RETURN
54403	RETURN	TYOUT2
75270	TYOUT2	TEMP0
20117	TEMP0	77
02177	77	TEMP2
40172	TEMP2	TEMP0
20177	TEMP0	77
40173	77	TEMP3
70312	TEMP3	T2
05124	T2	TEMP4
76000	TEMP4	TYST2
02403	TYST2	40
65477	40	3
34771	3	TEMP0
65220	TEMP0	TEMP1
70472	TEMP1	T1
04210	T1	TURN
4240	TURN	TEMP2
	TEMP2	4210
	4210	4240

T2
TYOUT2
TYST2

REM

3145	REM					
3146	REM	ADN	2	TEMP6		
3147	STD	LDC	STOP			
3150	STD	LDC	TEMP5			
3151	LDC		2020			
3152	STI		TEMP5			
3153	AOD		TEMP5			
3154	SBC		STOP			
3155						+51D
3156	NZB		6	TEMP6		
3157	JPI					
3160						
3161						
0602						
0607						
0608						
0609						
0610						
0611						
0612						
0613						
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0788						
0789						
0790						
0791						
0792						
0793						
0794						
0795						
0796						
0797						
0798						
0799						
0800						

BLKBUF

DECOCT
CONVERT BCD DEC TO OCT
12 BIT RESULT IN TEMPO

FIRST TWO INPUT CHARAC

FIRST CHARAC

SECOND CHARAC
LAST PAIR OF BCD CHARAC

CT	TEMP7
77	77
CT	4
0	CT
CT	1
12	CT
7	1750
CT	1
CT	1
5	CT
CT	12
12	7
14	4
CT	1
CT	2
5	CT
CT	12
6	12
CT	1
CT	3
4	CT
4	12
3	CT
CT	4
CT	TURN
REMP0	TEMP0
TEMP1	TEMP1
TEMP2	TEMP2
TEMP3	TEMP3
TEMP4	TEMP4

THIRD CHARAC

FOURTH CHARAC

3336 7054
 3337 4250
 3340 0006
 3341 7077

JPI
 JPI

OUTTYP
 OUTBUF
 OUTIND
 TEMP7

3342 0602
 3343 4040
 3344 7504
 3345 7451
 3346 7457
 3347 7040
 3350 4210

REM
 REM
 ADN
 STD
 EXF
 OTN
 OTN
 JPI

2 RETURN
 TYOUT5
 51
 57
 RETURN
 4210

3351 0602
 3352 4040
 3353 2005
 3354 4070
 3355 4070
 3356 4014
 3357 4405
 3360 6312
 3361 2174
 3362 0111
 3363 0111
 3364 0277
 3365 4076
 3366 0736
 3367 0114
 3368 4014
 3370 4014
 3371 6111
 3372 2174
 3373 0277
 3374 4076
 3375 0736
 3376 6103
 3377 6103
 3378 4014
 3380 0602
 3381 4040
 3382 2005
 3383 4070
 3384 4070
 3385 4014
 3386 4405
 3387 6312
 3388 2174
 3389 0111
 3390 0111
 3391 0277
 3392 4076
 3393 0736
 3394 0114
 3395 4014
 3396 4014
 3397 6111
 3398 2174
 3399 0277
 3400 4076
 3401 0736
 3402 6103
 3403 6103
 3404 4014

REM
 REM
 ADN
 STD
 LDD
 STD
 STD
 LDN
 STD
 SRD
 NJF
 LDI
 LDI
 LPN
 STD
 SBN
 NZF
 LDN
 STD
 NZF
 LDI
 LPN
 STD
 SBN
 NZF
 LDN
 STD

2 RETURN
 ON/OFF
 SWITCH
 TEMPO
 0
 EOBFLG
 SWITCH
 LOW1
 TEMP4
 77
 TEMP6
 36
 RC4
 1
 EOBFLG
 RC4
 TEMP4
 77
 TEMP6
 36
 RC4
 1
 EOBFLG

-1

TAB/LC

RESPONSE COMPARE

PROCESS FURNISHED ANSWER

EOB CHECK

3403	AOD	TEMP4	PROCESS STUDENT RESPONSE
3404	SRD	TEMP0	
3405	NJF	LOW	
3406	LS6	TEMP3	
3407	LPN	77	
3410	SBN	TEMP5	
3411	ZJB	20	
3412	NZF	RC4	
3413	LDI	RC	
3414	LPN	TEMP3	
3415	STD	77	
3416	SBN	TEMP5	
3417	NZF	20	
3420	AOD	3	
3421	NZB	TEMP3	SQUEEZE OUT SPACE
3422	AOD	RC4	
3423	AOD	TEMP3	
3424	LDD	TEMP5	
3425	SBN	36	
3426	NZF	4	
3427	LDD	EOBFLG	
3430	ZJF	7	
3431	LDD	4	
3432	SBD	TEMP5	
3433	ZJB	TEMP6	
3434	LDN	RC1	
3435	JPI	0	
3436	LDN	RETURN	
3437	JPI	1	
3440	REM	NO MATCH	
3441	REM		
3442	STF		
3443	PTA		
3444	JPI		
3445			
3446	LDC		
3447	HLT		
3450	REM		

3451	0602	REM	2	ADVLNE
3452	4040	ADN	RETURN	
3453	0462	STD	500	
3454	5007	LDN	TYPBUF	
3455	4027	RAD	BUFIN	
3456	3411	STD	LA SENT	
3457	6102	SBD	2	
3458	7003	NZF	RELAY2	
3460	7040	JPI	RETURN	
3461		JPI		
3501	3500	PRG	3500	
3502	0000	BSS	1	
3503	0023	BCDR	7	
3504	0013			
3505	0046			
3506	0020			
3507	0070			
3508	0045			
3509	0044			
3510	0000			
3511	0043			
3512	0051			
3513	0067			
3514	0071			
3515	0043			
3516	0025			
3517	0061			
3518	0031			
3519	0062			
3520	0022			
3521	0034			
3522	0022			
3523	0020			
3524	0030			
3525	0067			
3526	0027			
3527	0061			
3528	0026			
3529	0041			
3530	0010			
3531	0024			
3532	0050			
3533	0042			
3534	0011			
3535	0033			
3536	0000			
3537				
3538				
3539				
3540				
3541				
3542				
3543				
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3599				
3600				

[illegible]

3677	M1	BSS	1	CR/UC	NOT YET USED
3677		BSS	1	ERROR	NOT YET USED
3701		FLX	4547	IN OP CODE.	TRY AGAIN.
3701			29D		
3702					
3703					
3704					
3705					
3706					
3707					
3710					
3711					
3712					
3713					
3714					
3715					
3716					
3717					
3720	M3	FLX	4547	CR/UC	
3721			16D	DUPLICATE LABEL.	
3722					
3723					
3724					
3725					
3726					
3727					
3730	M4	FLX	4547	CR/UC	
3731			26D	NO CR BEFORE EOB-TRY AGAIN	
3732					
3733					
3734					
3735					
3736					
3737					
3740					
3741					
3742					
3743					
3744					
3745					
3746					
3747	M5	FLX	4547	CR/UC	
3750			26D	YOUR LAST COURSE RECORD IS	
3751					
3752					
3753					

40355 2
40354 2
40353 2
40352 2
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40016 2
40015 2
40014 2
40013 2
40012 2
40011 2
40010 2
40009 2
40008 2
40007 2
40006 2
40005 2
40004 2
40003 2
40002 2
40001 2
40000 2

FLX 457
6247
19D 4 UC
DIGIT START NUMBER

MC4 4557
4547
21D CR/LC
CR/UC
THE CORRECT ANSWER IS

MC5 4557
4547
14D CR/LC
CR/UC
COURSE ERROR.

MC5.1 FLX 23D INSTRUCTION TERMINATED.


```

4332 0000 STOP
4332 CRSBUF EQU STOP
0000 END

```


This listing was generated using the OSAS system which is a two pass assembler written for use with the CDC 160 computer. The CDC 405 card reader was used for symbolic input and the CDC 1607 magnetic tape units were used for intermediate input/output, listable output and binary output.

APPENDIX VI

DEFINITIONS OF SIGNIFICANT SYMBOLIC TERMS

<u>Symbol</u>	<u>Definition or description</u>
OUTIND	Index for the typewriter output buffer.
TYPBUF	Temporary storage for the first word of each line.
LASENT	Last word address of storage used by the course block in the computer.
LANUM	Last current reference number of the symbol table.
GOTO	Temporary storage for the argument of the GOTO request.
EOBFLG	A "1" indicates an EOB code has been encountered in the conversion routine.
CASE	A "1" flags upper case.
TEMLTR	Temporary storage for the most recent input typewriter character.
NAMBUF	Index for student name buffer area.
NATCOL	Variable index used in a symbol table search.
MATIND	Indicates the last word address of the current symbol table.
BUFCOL	Start of course storage area.
BUFIND	Index used for proceeding through course material.
OLD	Start of routine that searches tape for the beginning of the symbol table.
RST	Read symbol table.
START	Beginning of instructor input program.
CRA	Routine to analyze the contents of the label field.
LALIM	Label field character limit.

LAIN	Actual start of label field cracking.
MATCH	Seeks match for entry in label field.
NOMAT (NOMAT1)	Entry point when no match has been found for the label (branch).
STDUMP	Symbol table dump to tape routine.
NCR	Routine to analyze op code field.
NORMOP	Normal op code has been used.
NXLN	Next line.
BRNOP	Branch op code was used.
BRLIM	Branch argument character limit.
BRIN	Branch analysis routine.
STUDNT	Entry to student mode.
START2	Re-entry to student mode once established therein.
INRES	Input student response.
RIGHT(RIGHT1)	Entry point for a ca/cb (wa/wb) successful execution.
WRONG(WRONG1)	Entry point for an unsuccessful ca/cb (wa/wb) execution.
UN	Process UN argument.
BR	Process BR argument. Also entered at BR + 13 for GOTO statements.
BCDOCT (Z9Z001)	Special BCD to octal conversion for the number of words in the label-branch symbol table. Entered with two BCD numbers in TEMPO. Leaves 00XX ₈ in A.
TASTAT (Z9Z002)	Checks tape status. If the tape unit is ready the con- tents of A will be zero.

TAPE
(Z9Z003)

This is the generalized magnetic tape read/write routine. When the routine senses a parity error, three reads or writes will be attempted followed by an error halt.

Calling sequence:

p	PTA
p+1	JPl TAPE
p+2	first word address
p+3	last word address + 1
p+4	<u>address</u> desired for

return. Status left in A.

BCDTYP
(Z9Z004)

Converts 6-bit BCD to 6-bit type code. Input in TEMPO. Output in A.

TYPINP
(Z9Z005)

Converts input type code to BCD. Uses TYPIN as a sub-routine. Recognizes the double codes ".." and ",,". Input in TEMPLTR. Output in TEMP2.

PACK
(Z9Z006)

Packs two BCD characters into one computer word. Contains an internal switch to determine if character should go in upper or lower location. Input is right adjusted BCD character in TEMP2. Output is stored indirectly as determined by BUFIND which must be set before entry to PACK.

MATCH1
(Z9Z007)

Searches symbol table for a match to the symbol just generated. The storage index for the new symbol is BUFCOL. MATCOL is the variable index for the symbol table and MATIND holds the last address of the symbol table. If a match is found, (A) is non-zero.

TYPIN (Z9Z008)	Input routine for the typewriter code. Stores character in TEMPLTR.										
OCTDEC (Z9Z009)	Octal-decimal conversion routine. Input in TEMPO. Result by digits of descending order in TEMP1, TEMP3, TEMP4 and TEMP5.										
DECBCD (Z9Z010)	Decimal to BCD conversion. Input in TEMP6. Output in TEMP2.										
NUMPK (Z9Z012)	Adds symbol table reference number to line containing label or branch. Calls PACK and DECB CD. The input digits are located in TEMP1, TEMP3, TEMP4 and TEMP5. The routine also adds a carriage return code at the end of the line.										
OUTTYP (Z9Z013)	This is the generalized typewriter output routine. The calling sequence is as follows: <table border="0" style="margin-left: 40px; margin-top: 10px;"> <tr> <td style="padding-right: 20px;">p</td> <td>PTA</td> </tr> <tr> <td>p+1</td> <td>JPl OUTTYP</td> </tr> <tr> <td>p+2</td> <td>first word address</td> </tr> <tr> <td>p+3</td> <td>last word address + 1</td> </tr> <tr> <td>p+4</td> <td>normal return</td> </tr> </table>	p	PTA	p+1	JPl OUTTYP	p+2	first word address	p+3	last word address + 1	p+4	normal return
p	PTA										
p+1	JPl OUTTYP										
p+2	first word address										
p+3	last word address + 1										
p+4	normal return										
BLKBUF (Z9Z014)	Sets the buffer area to BCD blanks.										
DECOCT (Z9Z015)	BCD decimal to octal conversion. First pair of BCD character in TEMP6. Last pair in TEMP7. 12-bit result in TEMPO.										

TYCON (Z9Z016)	Executive control routine for the typewriter output. Calls BCDTYP for conversion and establishes an output buffer via the index OUTIND. The input buffer is indexed by BUFIND. This routine also sets up the first and last word addresses for OUTTYP.
TAB/LC (Z9Z017)	Outputs tab and lower case shift to the typewriter.
RESCOM (Z9Z018)	This routine compares the student response to the author supplied answers character by character. Spaces are ignored. The routine stops when an EOB code is encountered. Contents of A are non-zero when a match has been made.
CRSERR (Z9Z019)	This routine sets up OUTTYP for a course error message.
ADVLNE (Z9Z020)	This routine steps the index TYPBUF by increments of 50 ---the number of storage words required to hold 100 packed characters. It also sets the initial value of BUFIND.
TA_____	All symbolic codes with this prefix refer to the tape unit.
TY_____	All symbolic codes with this prefix refer to the typewriter.

APPENDIX VII
SYMBOLIC REFERENCE TABLE

0073	TEMP3	0234	0241	0562	0563	0565	1642	1643	1647	1752	2005	2013
0074	TEMP4	2130	3061	3127	3405	3414	3421	3423	2016	3067	3131	3362
0075	TEMP5	0564	0566	0600	0610	0622	0645	1646				
0075	TEMP5	3402	0655	2351	2356	3075	3151	3154	3155	3410	3416	3424
0076	TEMP6	06C3	0614	0624	3033	3054	3062	3070	3076	3146	3161	3170
0077	TEMP7	3204	3365	3375	3433							
0077	TEMP7	0675	1576	1577	1600	1605	1613	1614	3176	3207	3213	3261
0252	TERM											
3014	THRMOR	3021										
2746	TWO	3013	1402	1435	1617	1676	2043	2150				
3005	TYCON	1360										
0057	TYOUT2											
3143	TYOUT5											
3350	TYOUT5											
0007	TYPBUF	1345	1641	2067	2156	2206	3454					
0050	TYPINP	0160	0333	2535	2567	2607						
0045	TYPINP	0724	1012	1071	1224	1252	1410	1502				
0126	TYST1											
3144	TYST2											
3120	T1											
3142	T2											
3142	T2											
2667	UC											
2135	UNPC2	2107	2154	2172	2201							
2512	UPPER											
3215	USED											
3216	WA	2165	2104									
2015	WB	2102										
2752	WRONG	1773	1775	2009								
1737	WRONG1	2116	2120	2123								
2071	X1	1210										
1135	X5											
0466	Z1	0632										
0576	Z1	0634										
0606	Z2	0636										
0620	Z3	0640										
0627	Z4											
0570	Z5											
2320	Z9Z001	0046										
2350	Z9Z002	0041										
2357	Z9Z003	0043										

2444	Z9Z004	0044	0720
2532	Z9Z005	0045	
2672	Z9Z006	0046	
2753	Z9Z007	0047	
2763	Z9Z008	0050	2761
3031	Z9Z009	0051	30C4
3042	Z9Z010	0052	
3110	Z9Z012	0053	
3145	Z9Z013	0054	
3162	Z9Z014	0055	
3260	Z9Z015	0056	
3342	Z9Z016	0057	
3351	Z9Z017	0060	
3441	Z9Z018	0061	
3451	Z9Z019	0062	
	Z9Z020	0063	

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